PDT
2015

A Common Product Language as the Basis for Innovation

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Contents

1 The challenge to create an innovative information environment

This paper presents how Saab Kockums established an innovative information environment to enhance the development and support of their products by the introduction of a "Backbone Architecture" using ISO10303 AP239 (PLCS) as information model.

A challenge for anyone involved in life cycle management of a product is to provide the large number of stakeholders involved with relevant information. Key to facilitate this is to establish an information model understandable for the disciplines involved.

Product Lifecycle Management (PLM) is a about managing product information over the entire product lifecycle, from capturing customer/market needs to disposal. The information is created and used by different organizations (partners, suppliers, customers) and disciplines (development, production, maintenance, etc).
Many different kinds of Softwares, designed for specific tasks and from different software suppliers, are used throughout the life cycle.

In this scenario the possibility to automatically create, exchange, and access information independent of Softwares is an important feature. However, it is our experience that most information is "locked in" by specific Softwares and needs to be transferred manually or re-created. Another problem for effective exchange is that different Softwares have their own "local language" for the names and definitions of the objects managed by the application, as well as different business domains have their own "local language".

A further challenge is that the enterprise process descriptions are typically at too high a level to describe the appropriate usage of Softwares and related information flows. The information flows need to be described at activity (method) level to ensure that a task downstream is supplied with information generated upfront. In most cases today information from different softwares needs to be (re)created as input to the subsequent tasks. In addition, often the input information have become invalid due to uncontrolled changes.

While the process and methods presented include some organizational specific elements, we believe that the approach and conclusions are valid for all industries dealing with life cycle management of complex products and services.

2 Saab Kockums PLM as an organizational capability

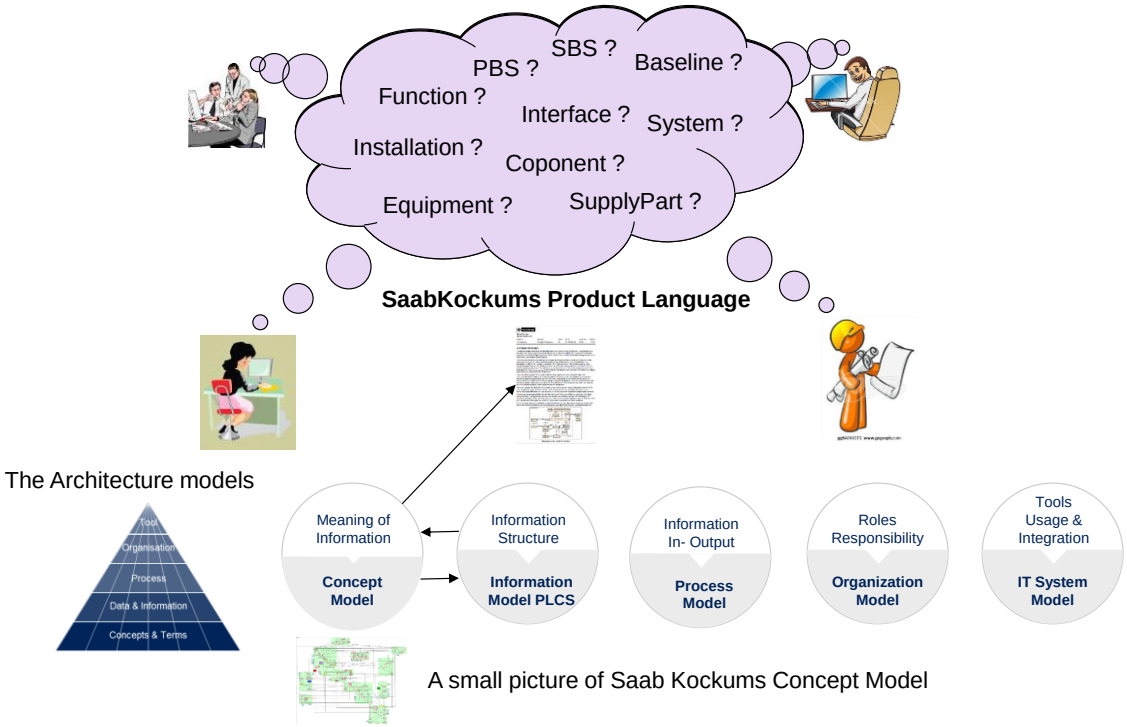
To establish a capability for organizational PLM and IT in general, Kockums not only addressed the proper information and Softwares, but also people with defined roles and the right professional expertise and knowledge in the processes and tools used.

In an ever changing organizational environment this becomes a challenge and it is essential that the organization provides the appropriate training and support as well as clear management policies and guidelines for the work to be performed.

The core of Kockums' PLM implementation is focused on information due to the fact that the product information for naval ships need to be kept alive, and in good health, for the whole product lifecycle. Life cycles that can be 50 years. During this period, Softwares and IT need to be replaced without loss of relevant information. A basis for this is to define the information that is needed.

To be able to correctly understand the information needs from many different disciplines and in different organizations inolved in the life cycle management, the Kockums Concept Model was developed as a part of the PLM core.

The Saab Kockums Concept Model is also used to establish a minimum shared company "Product Language". The Product Language is based on, and mapped to, PLCS to translate PLCS generic concept to Kockums business context.
PLCS is selected as an information standard for the entire product lifecycle to enable software independent data exchange and integration.



A small picture of Saab Kockums Concept Model

Even if the Saab Kockums Concept Model and the Standardized Information model (PLCS) form the core of Saab Kockums PLM, they needed to be implemented in a context that put them to work. This context includes:

- Information Pyramid metaphore that makes people aware of that softwares do not solve the problem without considering organizational, process/methods, information and concept/terminology dependencies.
- Backbone Architecture that implements the integration between local Softwares and the PLCS Backbone.
- The Architecture Model that manages the models for the different Pyramid layers.
- Architecture Governance as a part of IT governance that connect PLM to the IT and Business strategy.

The Product Language, as a part of the Backbone Architecture, is the basis for interdisciplinary communication both internal and external, methodology descriptions, engineering training and an extended and more qualitative usage of Softwares.

Getting all of the above issues to work as a whole was the premises for the work undertaken by Saab Kockums.

3 Saab Kockums Business Context

Saab Kockums develops and supports advanced products with large amounts of associated information to be managed over their life cycle. The company started the PLM journey 10 years ago with the PDM/CM Project with the aim to replace old CAD systems and introduce Configuration Management. The CAD system replacement was put on hold due to the global financial crisis. But as an outcome from the PDM/CM Project, the PLM Project approach was defined, illustrated by the Information Pyramide. This approach is described in the PDT Europe 2006 Paper "Experiences of PLM implementation in the defence industry".

All these aspects mentioned above on successful IT-usage (not only PLM) need to be documented and managed. At Saab Kockums, the unit DIBO (headed by Torbjörn Pettersson), responsible for the interface between business and the IS&IT-Service suppling organization (ICT), have implemented an IT-Governance model supported by an integrated and sustained architecture model.

The expected business benefits for Saab Kockums PLM journey:

- More innovative products
- More usable product information (enables Model Based Definition)
- Reduce risks in offerings
- Shorter time to market
- Lower production costs
- Lower development cost by design reuse
- More profitable aftermarket business

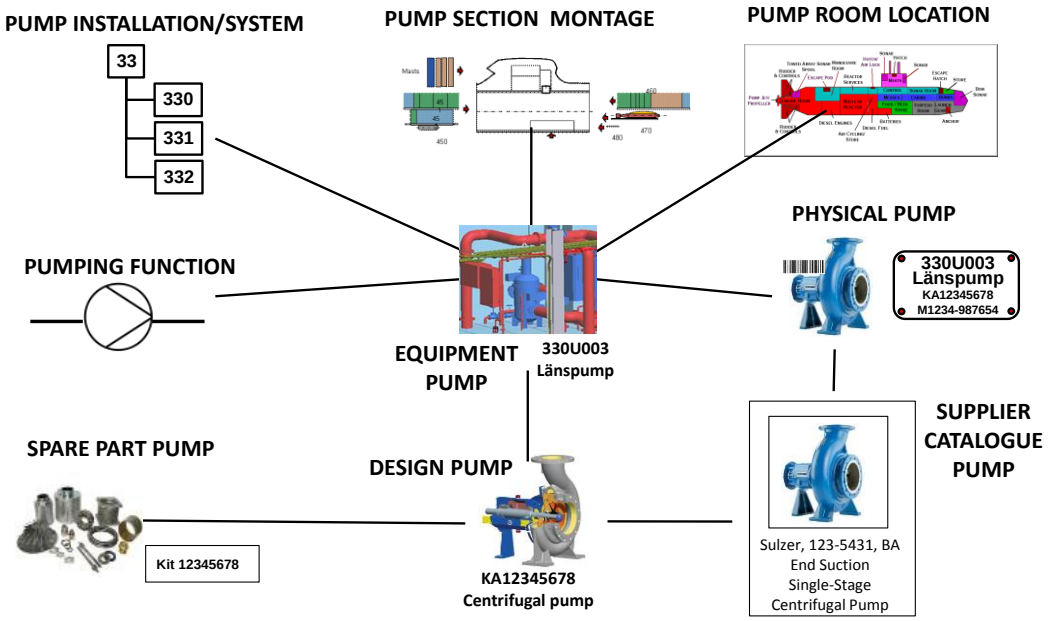
4 Saab Kockums PLM Approach

4.1 Understanding the complex nature of product information

An important circumstance to the complex nature of product information in a PLM scenario is that the information shall form a consistent representation of the product and its sub-division within physical and functional views over the product life cycle, a Through life product model

The product information needs to meet the needs from all disciplines involved in managing, specifying, developing, procuring, producing, maintaining and disposing the product.

This results in a lot of interrelated information objects carrying different subsets of information about the product that need to be structured and correctly related to the digital product representation and its sub divisions.



The challenge is that the information is broken up into information subsets and "locked in" in a lot of different softwares because the softwares are designed to support different kind of tasks for different disciplines.

The "locked in" problem is counteracted by the use of information standards (PLCS) and IT-architecture for integration (Backbone Architechture). The "local language" problem is managed by a global semantic definition of information within the PLM scope (the Product Language).

This information subsets are difficult to interconnect, achieving Information Integration, with related information subsets from other softwares due to poor usage of information standards. By using the global information model and the Product Language information, integration of local information subsets is standardized and facilitated.

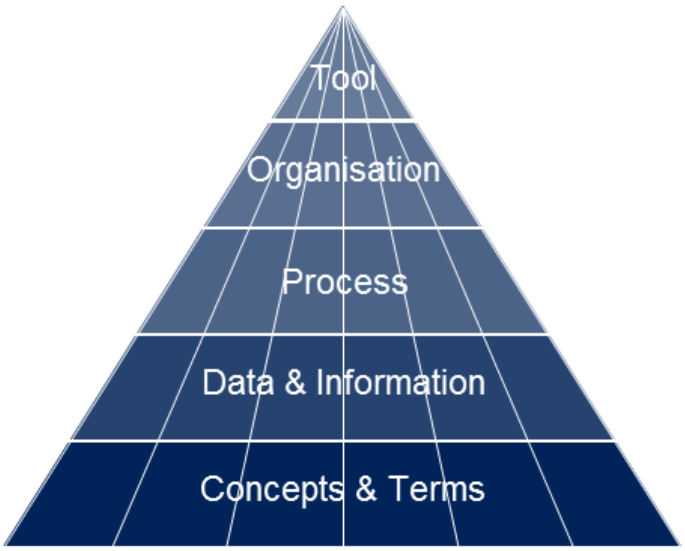
4.2 The Information Pyramid

Information and Concepts are not enough to succeed in PLM. Other areas to be managed in a successful PLM implementation are, as illustrated by Saab Kockums Information Pyramid, Processes and Methods, and Organizational aspects on IT usage.

The approach is illustrated by the different layers in the Saab Kockums Information Pyramid.

From bottom (an order of stability)

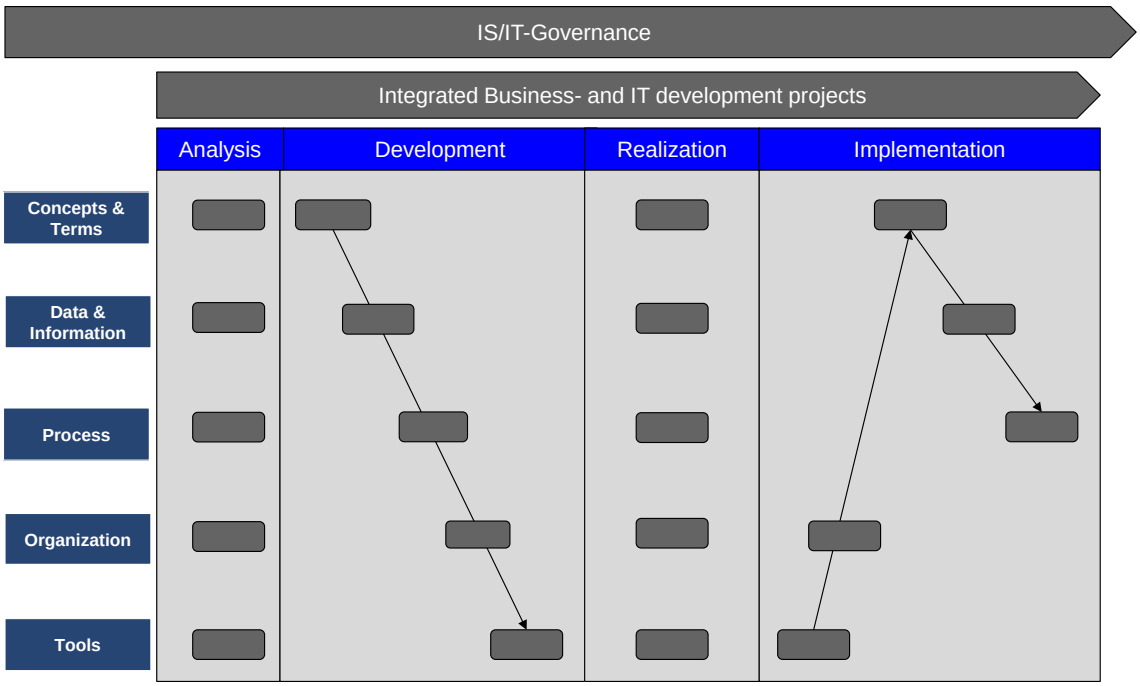
- Tools (Software)
- Organization
- Processes
- Data & Information
- Concepts and Terms



Therefore Saab Kockums decided to establish an IT-architecture based on the Information Pyramid to facilitate integrations, by using a standardized Information Model (PLCS) that covers the information scope for all softwares involved in the product lifecycle.

This is enforced by using models for each level in the pyramid, defining interfaces within layers as well as between them. Models are used also for sustainment of IT environment, when new investment in software is desired or planned, and to evaluate the need for additional or enhanced application functionality.

The different layers of the pyramid forms the basis for planning, governance and execution of IT-projects as illustrated in the picture below.



4.3 A common product language

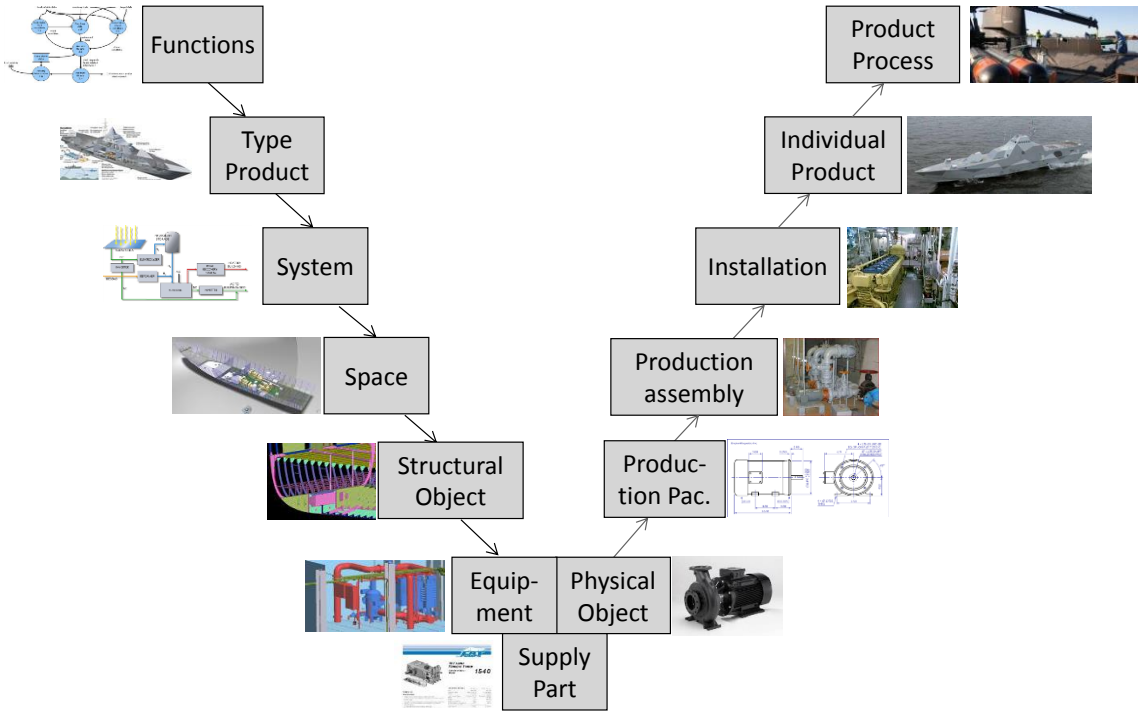
As described above the basis for effective life cycle management of product information is the consolidation of the concepts used and the associated product language.

With the purpose to provide Saab Kockums employees with a common understanding of the basic product concepts, the development of a company product language was an early step.

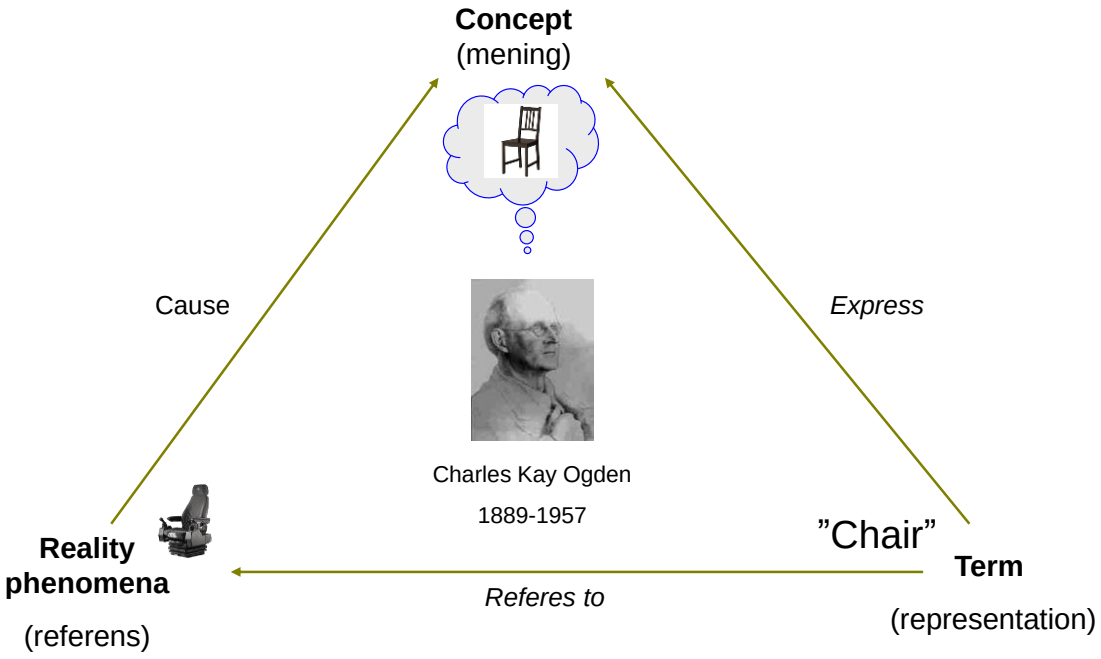
The contribution to the business is:

- Common concepts, understanding what we are talking about, understanding when we have same term for different concepts, and different terms for same concepts, and harmonize this.
- Implementing system integration based on the concepts we create and manage in our systems, through a concept model mapped to a standard information model (PLCS).
- Usage of these concepts when defining/describing processes and working methods, ensuring a consistent usage of the concepts and terms within the organization.
- Usage of these terms also in methodology documentation and instructions for how to handle applications and software, and mapping to the software specific terms used by their user interfaces.

The most important concepts during product development are illustrated in the picture below.



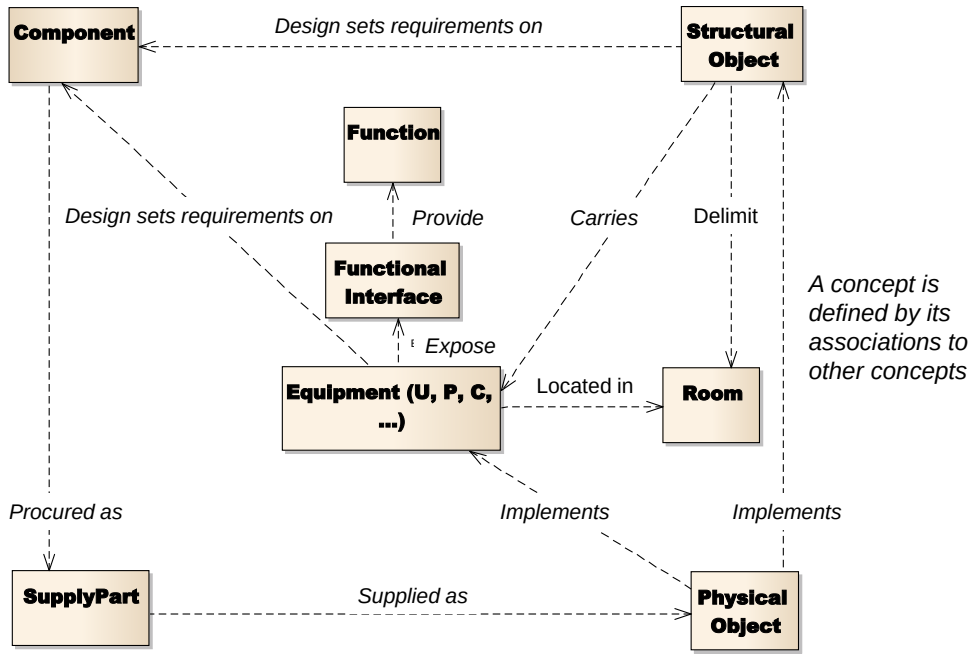
The theory for concept is often illustrated by Ogden's triangle by Charles Ogden.



Reality phenomena's is mentally represented as concepts. Concepts give meaning and is expressed through Terms. The term refers to the phenomenon that is the originator of the concept.

The degree of knowledge on a subject is depending on the amount of relevant concepts for the subject and associations that is mastered. An advocate master correctly much more juridical concepts than an engineer.

Concepts and their relations can be graphically documented in a concept model as the example below from Saab Kockums' Architecture model.



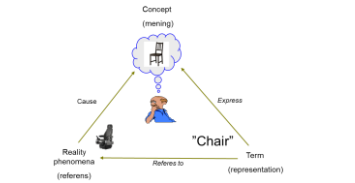
The product language presents a limited selection of the terms and concepts that are fundamental to the product information in the company's Software's.

The product language does not incorporate different domain specific concepts but focus on common concepts that need to have the same meaning regardless of their domain.

The concepts in the product language is modelled in a concept model. The concept model is also used to:

- Map the concepts to PLCS Information model
- Defining information content in different Softwares
- Identify needs to link information
- Naming of product terms in Processes, Workflows and Methodological descriptions

In Kockums' Architecture model we selected a view that defines Concept, Information and Data as different but interrelated phenomena's.



Concept

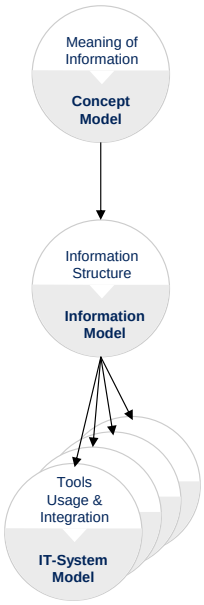
A concept is a mental representation, which the brain uses to denote a class of things in the world

Information

Information is knowledge communicated or received concerning a particular fact or circumstance

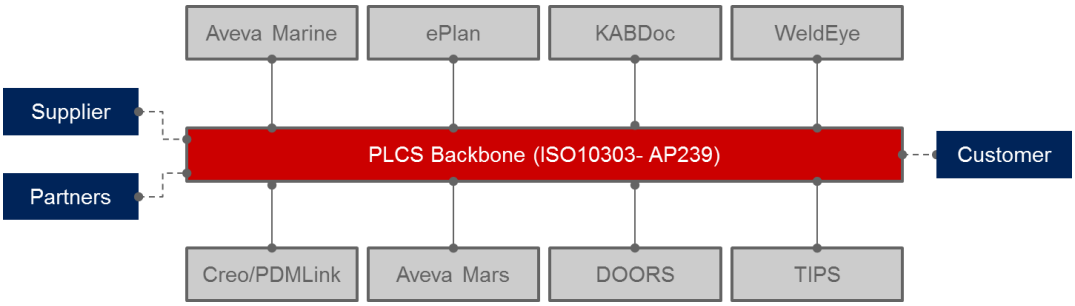
Data

Data is any sequence of symbols given meaning by specific acts of interpretation



4.4 IT-Architecture implications

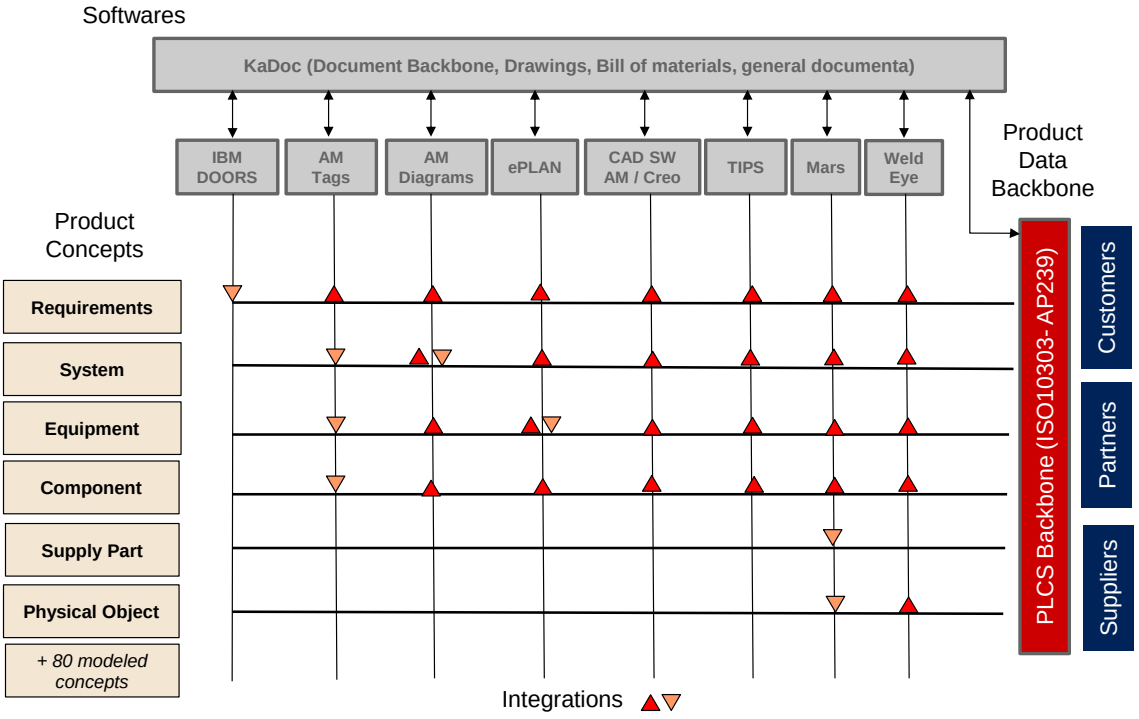
The PLCS Information model is implemented by a "Backbone" software (Eurostep Share-A-space). The Backbone connects and synchronizes information in local softwares and establish a global information environment. The scope with the backbone is to be invisible for most users, they continue to work in their ordinary softwares. But the users will have better possibilities to work with information needed to be shared by other systems to avoid today's manual information transfers,



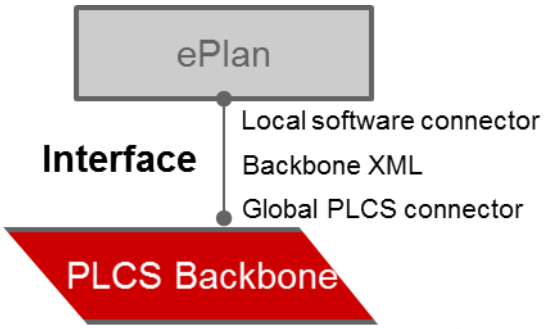
A key feature with the backbone is that the disparate information from connected system will form a united, standardized, integrated and conceptually coherent information set, the Through life product model.

The Information matrix (the principles illustrated by picture below) form the Architecture model shows the interfaces and what information is transferred between local systems and the Backbone.

On the top the Document Management system KabDoc is illustrated with interfaces for drawings and part lists. Below is a row with all the software's belonging to PLM presented with their interfaces upwards to KabDoc and downwards to the Backbone. The triangles in the columns illustrates integrations for different information-types to and from the Backbone. On the left side is the Product Language concepts defining the names in each row to be used for the information in the integrations.



The principles for Integrations are the usage of Interfaces with a local and a global connector.



The local connector is as simple as possible and uses the local software's data definitions, exchange and integration features. The local connectors is mapped to a simple XML transfer-format "Backbone XML" with information objects named according to the Kockums Product Language. The Backbone XML information objects is mapped to PLCS by the global connector to the Backbone. Most of the transfer processing, PLCS transformation and information consolidation (import rules) are executed on the global connector of logic in the backbone.

This solution provide two views of the information, one with the unified naming of the information objects based on Kockums product language and, one with the information standardized and structured acording to PLCS. The PLCS structure is more complex to allow all the different kind of processing by the different kinds of softwares ower the product lifecycle.

4.5 IS/IT Governance

4.5.1 Governance model

The PLM environment is a clear and integral part of the Saab Kockums IS/IT environment and its governance. The governance model is based on the PLM "Information pyramid".

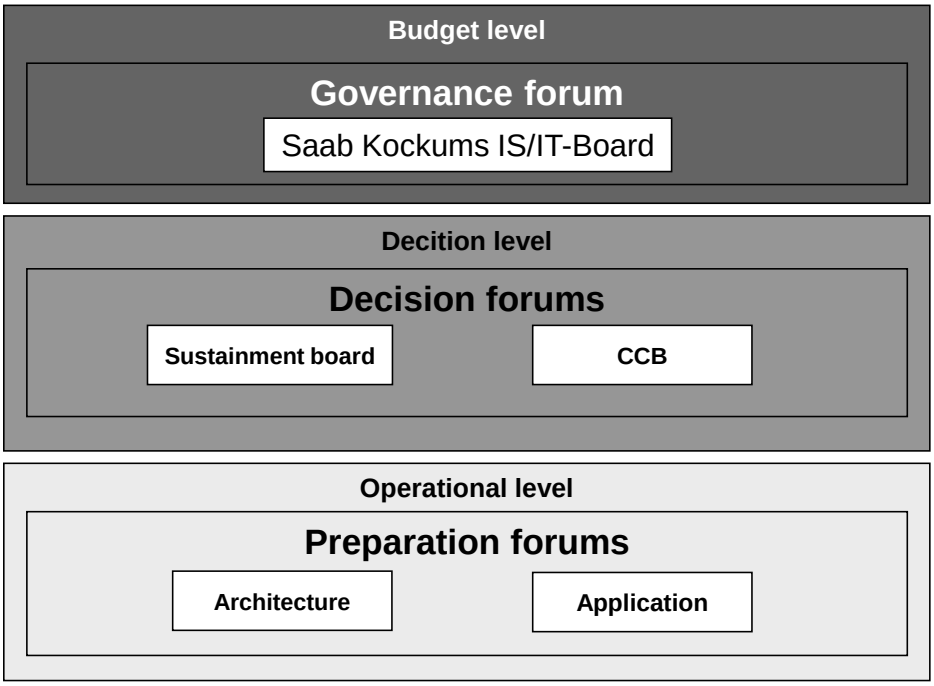
Governance of IS / IT environment within Saab Kockums refers to the overall activities undertaken to maintain, develop, administer and manage Saab Kockums (SK) overall IS /IT environment in line with the development and changes of the business unit's operations, organization and strategy.

Purpose of the governance model is to achieve the best possible weighted cost of developing and maintaining the IS/IT environment to provide intended functionality and accessibility.

Governance is carried out at different levels with principal responsibilities as follows:

- Budget Level (corporate)
- Decision Level (governance)
- Operational level (management)

Governance, management and executive work within the IS/IT management is implemented in various fora.



What is sustained is specified in the governance structure. The upper levels are shown in the figure above.

The scope for SaabKockums IS/IT governance is defined by the IS/IT governance structure (top level):

- Operations
  - IS / IT Management
  - IS / IT Organization
  - IS / IT Services
- System Support
  - Architecture
  - Softwares
- Infrastructure
  - Servers
  - Clients
  - Network

Within the support systems level the architecture for Saab Kockums overall IS/IT environment is documented by the Architecture Model described in this document. The purpose of architecture is to achieve a consistent and manageable IS/IT environment that facilitates integration and replacement of old Softwares without information losses.

This means that the architecture is divided into the different layers of the Information Pyramid (softwares, organization, process, information and concepts) in order to

describe the model elements in each layer and their dependencies (interfaces) to model elements in other layers.

Documenting and managing the architecture, a model-based solution is used. This is further described in this paper. It means that the IT environment architecture with its dependencies is documented as linked object patterns. This results in a comprehensive, integrated, version controllable and developable Architecture Documentation.

To work with questions concerning the architecture the preparation forum "Architecture" has been established. The forum prepares decisions and recommendations in connection with the development and change of IS / IT environment.

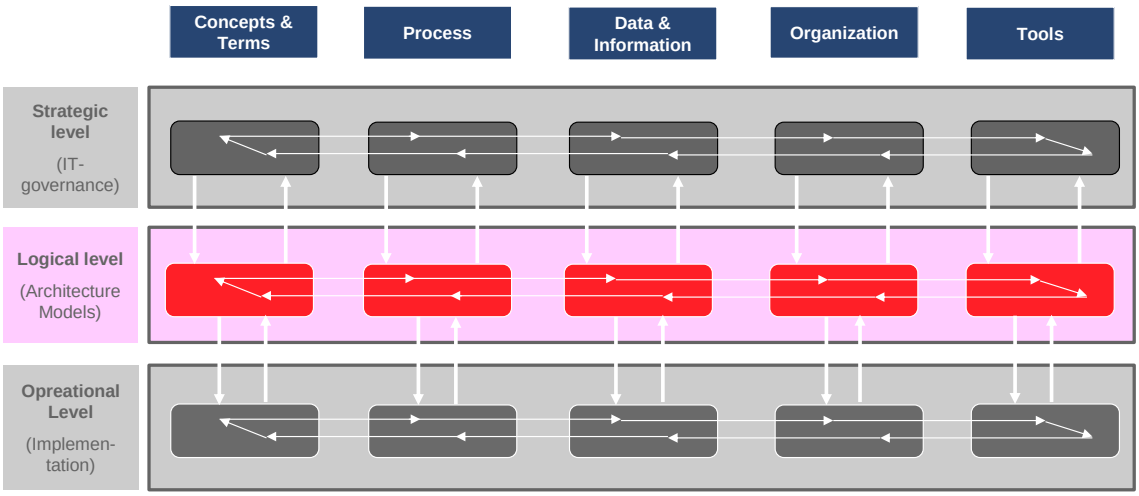
4.5.2 Architecture models connecting strategy and operation

To support the company strategy work the Architecture models (the middle layer in picture below) are used to provide consistent evaluation data and decision support to the "Saab Kockums IS/IT-Board".

An important contribution from the Architecture model is to make it possible to better consider Organisational, Process, Information and Concept (Intellectual Capital) aspects of IT-Investments.

The Governance board owns and governs the models to secure a consistent documentation of Saab Kockums IS/IT Architecture. The Architecture model is here used to follow up and assess existing IS/IT environment and to plan, analyse and calculate for business changes that affects IS/IT

At operational level the "Architecture preparation forum" manages and follow up the implementation of the architecture models.



The Architecture model is documented by Model templates that identify, set name, set status and relate the modeled information. Some of the most important are described below for each layer:

Software
- Environment
- Software
- Interface
- Integration
- Data

Organization
- Role
- Actor
- Competence

Process
- Process deliverable
- Activity
- Workflow
- Method

Information
- Information flow
- Information object
- Attributes

Concept
- Concept definition
- Terms used for the concept
- Competence area as context for concept

The architecture model is built up from one sub model for each layer. Dependencies between Model elements within and between the layers are documented by links. Diagrams are used to create formal and ad hoc graphical views to and across the different sub models. The information in the model is stored in a package structure for each layer with pre-defined excel export/imports. Excel templates are defined to be used as input and output formats for the Architecture model.

5 Conclusions

The unified naming of Information by the company Product language provide a shared understanding of the information, and the integrated acess to information processed in a lot of different softwares internaly and externaly establish an innovative environment that significantly extend the sharing of knowledge in time and space.

The concept model and its mapping to the PLCS information model have facilitated integrations by making it easier to determinate what is the same or different information in all softwares involved in Saab Kockums PLM.

The usage of PLCS as information standard and the Backbone Architecture to interface producut development softwares have made it possible to give in-service support

softwares standardized and configuration controlled access to design information that is needed for support.

It have been a long journey (more than 10 years) to increase the organizations understanding that there is more tings than by a software as the solution. During this time the sofwares, organization and processes have shifted but the information and concepts have been stable and better known and defined for each year.

The approach to shift the focus from softwares to concepts and information have been a important enabler to more work with the real problems in using softwares than the softwares themselves. (*We use to say that it is often much better to start to use existing softwares in their intended way than ask for new*).

As the times go by more and more of SaabKockums product information will be safeguarded for the future by standardized information formats in the integrations to the Backbone Arhitecture.

To achive the full potential of the organization's IT-usage, also the business related aspects of IT (as illustrated by the pyramide) need to be documented and sustained by an architecture model that makes the elements in each layer and their relations visible.

The architecture model is an important tool to create decision support to IT-governance regarding consequenses for IT-investments and software replacements.

6 Results

- ✓ The "Product Language" have established a common base to communicate about the product in a more innovative environment.
- ✓ The concept model, and its mapping to the PLCS information model, have made the information more visible.
- ✓ The Backbone Architecture have made design information more available to future production and in service support.
- ✓ The PLM work has been possible to continue in many years with few disruptions by the focus on information as the most stable layers of the Information Pyramid.
- ✓ The Information Pyramide increased the understanding of what is needed for a successful IT usage.
- ✓ Saab Kockums product information will be safeguarded by the standardized information formats.
- ✓ The organizations IT-usage is better documented and sustained by a architecture model that covers all the Information pyramid layers.
- ✓ The Architecture model is a important decision tool supporting IT-governance.

7 Terms and Definitions as used in this paper

PLCS, Product Life Cycle Support, ISO 10303-239.

PLM, the management of product information over the entire product lifecycle, from capturing customer/market needs to disposal Information model.

Architecture, fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution. (ISO/IEC 42010), In the context of this paper the system is an Enterprise and its subdivision in Tools (Software's), Organization, Processes, Information and Concepts (Terminology).

Model, a consistent representation of a phenomena and its attributes by viewers that satisfy the model stakeholders within the scope of the model. The model is documented by Model elements.

Model elements template, a template classified of a Meta model defining the model elements and their possible relationships.

Model element, a instance of a model elements template with actual data and relationships representing the modeled phenomena within the model element template scope.

Architecture model, a model of Architecture.

Through life product model, a consistent representation of the product and its sub-division within physical and functional views over the product lifecycle by a united, standardized, integrated and conceptually coherent information set.

Concept, a mental representation, which the brain uses to denote a class of things in the world.

Concept model, a representation of concepts terms and domain elements with their relationships and attributes.

Information, knowledge communicated or received concerning a particular fact or circumstance.

Information Model, a representation of information object classes with their relationships and attributes.

Information set, a defined and amount of information.

Information sub set, a defined subset of an specific Information set.

Information Integration, information subsets that are connected to establish a composed set of related information.

Information Object, an identifiable, delimited, manageable amount of information.

Data, any sequence of symbols given meaning by specific acts of interpretation.

Data model, a representation of data elements with their relationships and attributes.

Backbone architecture, an architecture with a software to facilitate integrations by interfaces with most of the functionality at the backbone side, global connectors to facilitate the local software integration's local connectors.

Local Interface connector, interface integration to local software.

Global Interface connector, interface integration to backbone.

Global information environment, a united, standardized, integrated and conceptually coherent information set with software independent information access.

A. Biography

Torbjörn Pettersson, Deputy Information Business Officer, Saab Kockums.
Senior Vice President IS/IT Thyssenkrupp Marine Systems AB
IS/IT Manager Kockums AB
Torbjörn has a history of working with not only traditional IS/IT issues, but he has also for many years been closely involved in PLM/ERP topics. His experience in those areas derives from strategic and implementation management as well as operations management.

Ulf has worked Since 2001 as a consultant towards defence industry in areas such as Process development, IT-Strategy and implementation of business management systems As a senior consultant for Syntell, Ulf has mainly worked with Configuration Management and Information Management for large-scale defence projects. In addition, Ulf has been involved in the early development of an international standard for product data ISO 10303:ap239 PLCS “Product Life Cycle Support”.

Peter Bergström is principal consultant since 20 years at Eurostep AB, and has a long experience of implementation projects in various business domains. Peter has a long history with international standards such as SGML (ISO 8879) and XML, S1000D, STEP (ISO 10303) and PLCS (ISO 10303:239).
For the last 10 years Peter has participated in the CM/PDM, PLM and MBD projects at Saab Kockums.

B. Acknowledgements

Thomas Hedberg Saab Kockums
Tom Strandberg Syntell

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